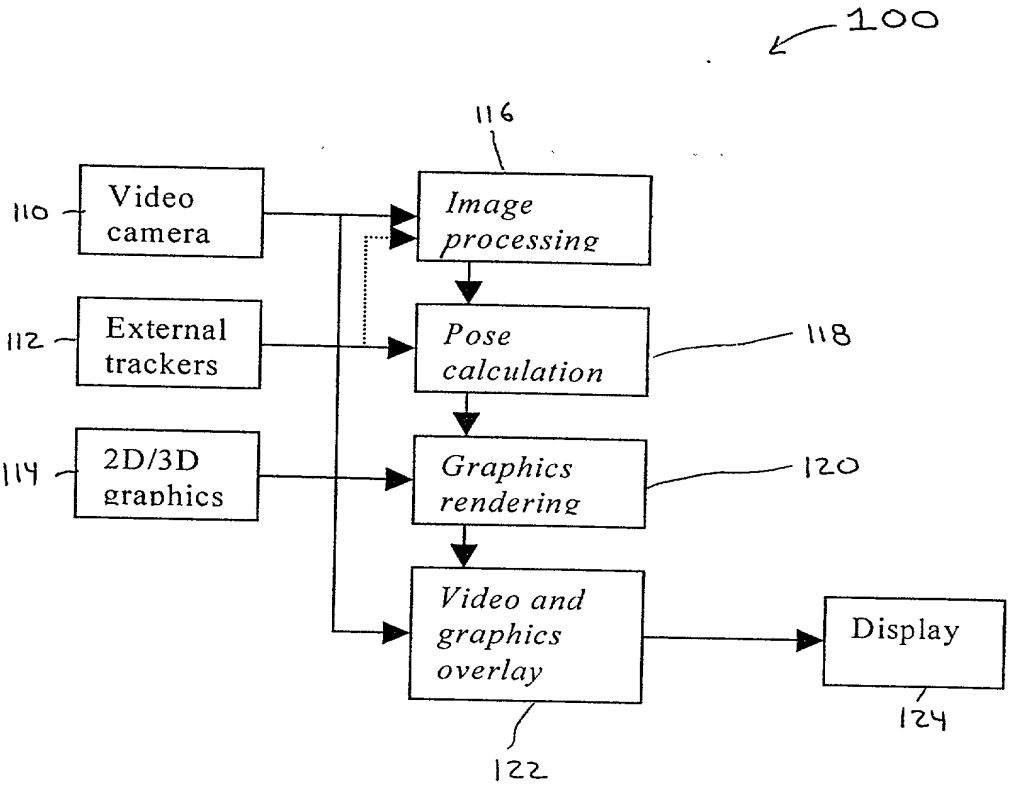

100
116
110
Video camera
Image processing
112
External trackers
Pose calculation
118
114
2D/3D graphics
Graphics rendering
120
Video and graphics overlay
Display
122
124

FIG. 1

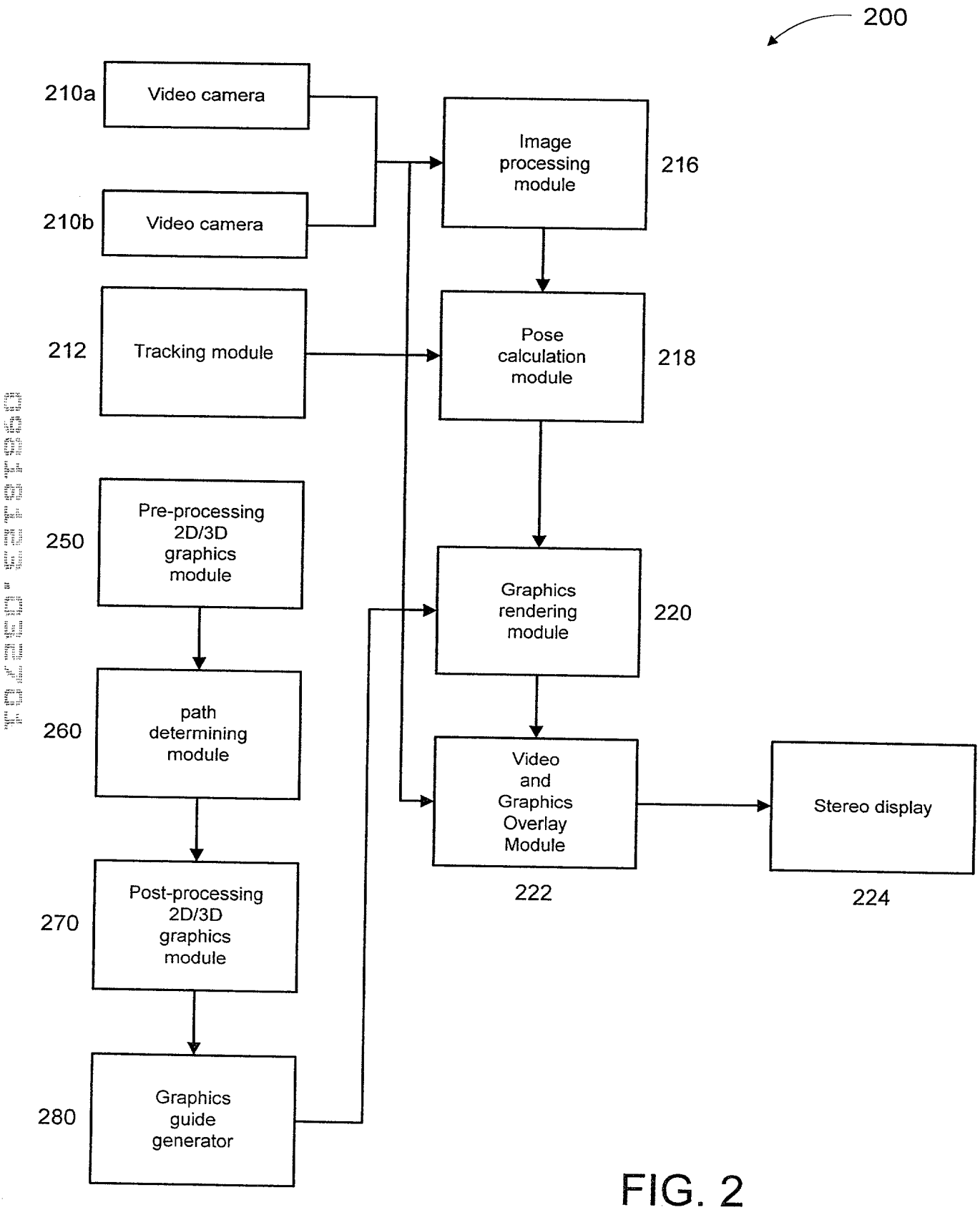

200
210a
Video camera
210b
Video camera
212
Tracking module
250
Pre-processing 2D/3D graphics module
260
path determining module
270
Post-processing 2D/3D graphics module
280
Graphics guide generator
Image processing module
216
Pose calculation module
218
Graphics rendering module
220
Video and Graphics Overlay Module
222
Stereo display
224

FIG. 2

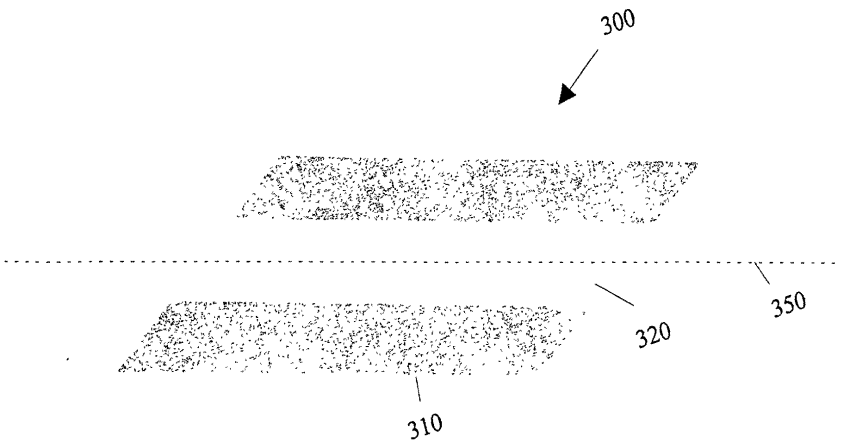


FIG. 3

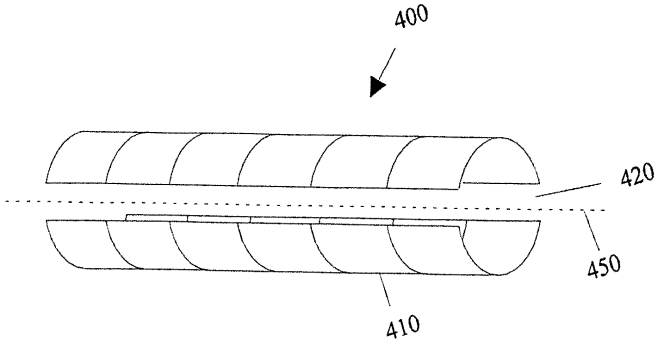


FIG. 4

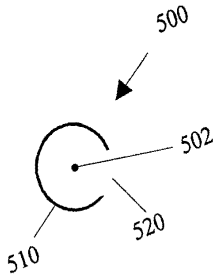


FIG. 5

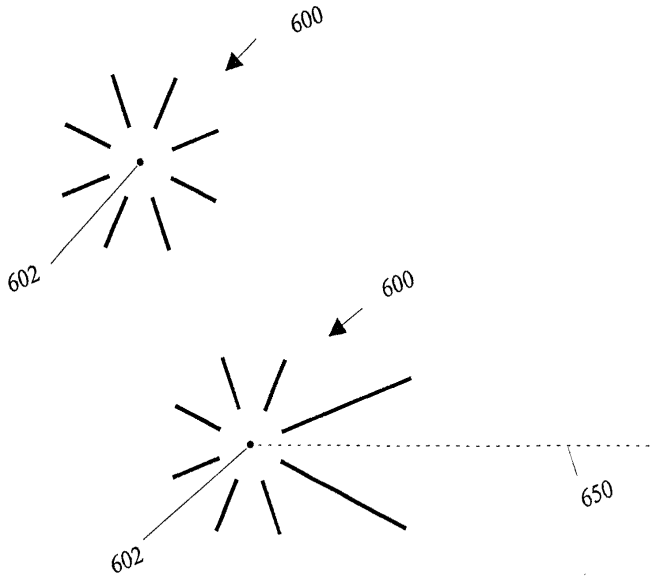


FIG. 6

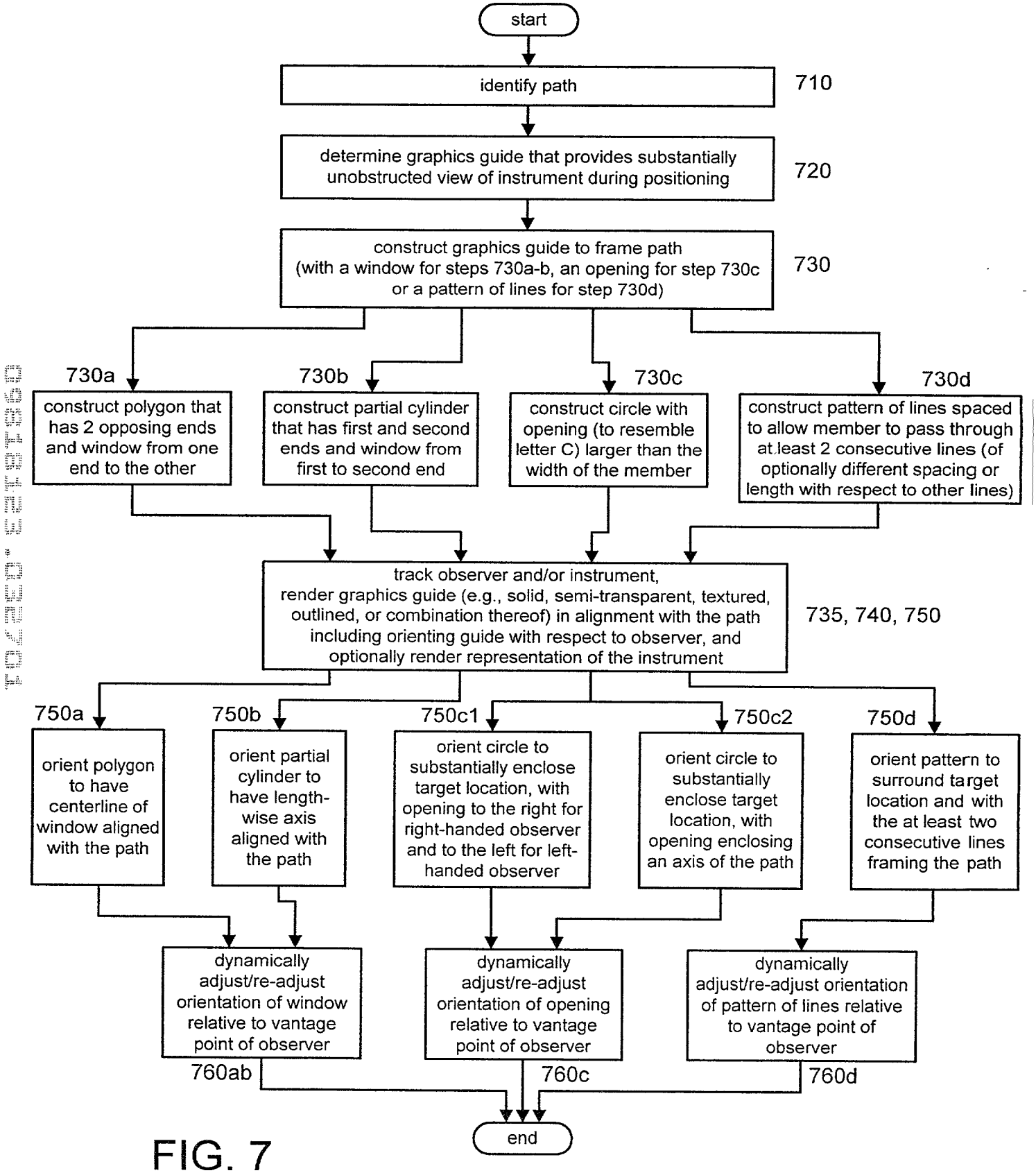

start
identify path
710
determine graphics guide that provides substantially unobstructed view of instrument during positioning
720
construct graphics guide to frame path (with a window for steps 730a-b, an opening for step 730c or a pattern of lines for step 730d)
730
730a
730b
730c
730d
construct polygon that has 2 opposing ends and window from one end to the other
construct partial cylinder that has first and second ends and window from first to second end
construct circle with opening (to resemble letter C) larger than the width of the member
construct pattern of lines spaced to allow member to pass through at least 2 consecutive lines (of optionally different spacing or length with respect to other lines)
track observer and/or instrument, render graphics guide (e.g., solid, semi-transparent, textured, outlined, or combination thereof) in alignment with the path including orienting guide with respect to observer, and optionally render representation of the instrument
735, 740, 750
750a
750b
750c1
750c2
750d
orient polygon to have centerline of window aligned with the path
orient partial cylinder to have length-wise axis aligned with the path
orient circle to substantially enclose target location, with opening to the right for right-handed observer and to the left for left-handed observer
orient circle to substantially enclose target location, with opening enclosing an axis of the path
orient pattern to surround target location and with the at least two consecutive lines framing the path
dynamically adjust/re-adjust orientation of window relative to vantage point of observer
dynamically adjust/re-adjust orientation of opening relative to vantage point of observer
dynamically adjust/re-adjust orientation of pattern of lines relative to vantage point of observer
760ab
760c
760d
end

FIG. 7

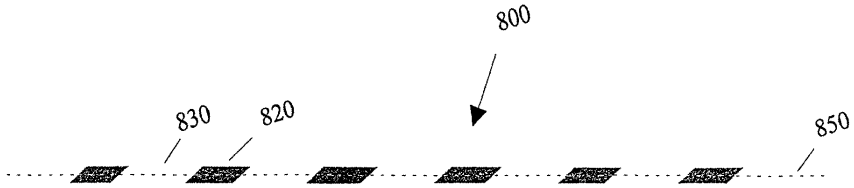


FIG. 8

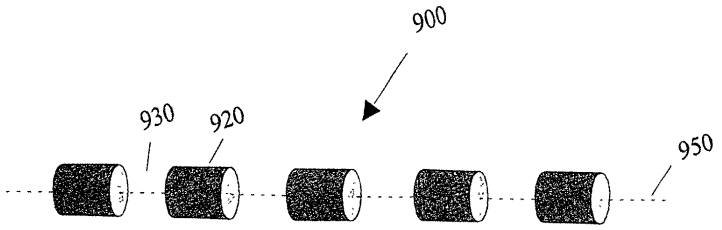


FIG. 9

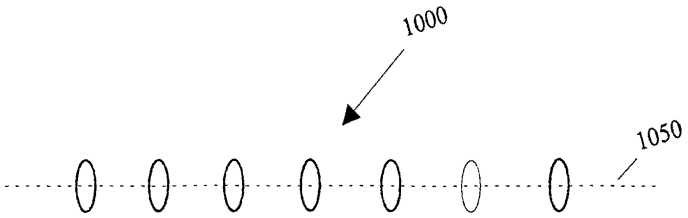


FIG. 10

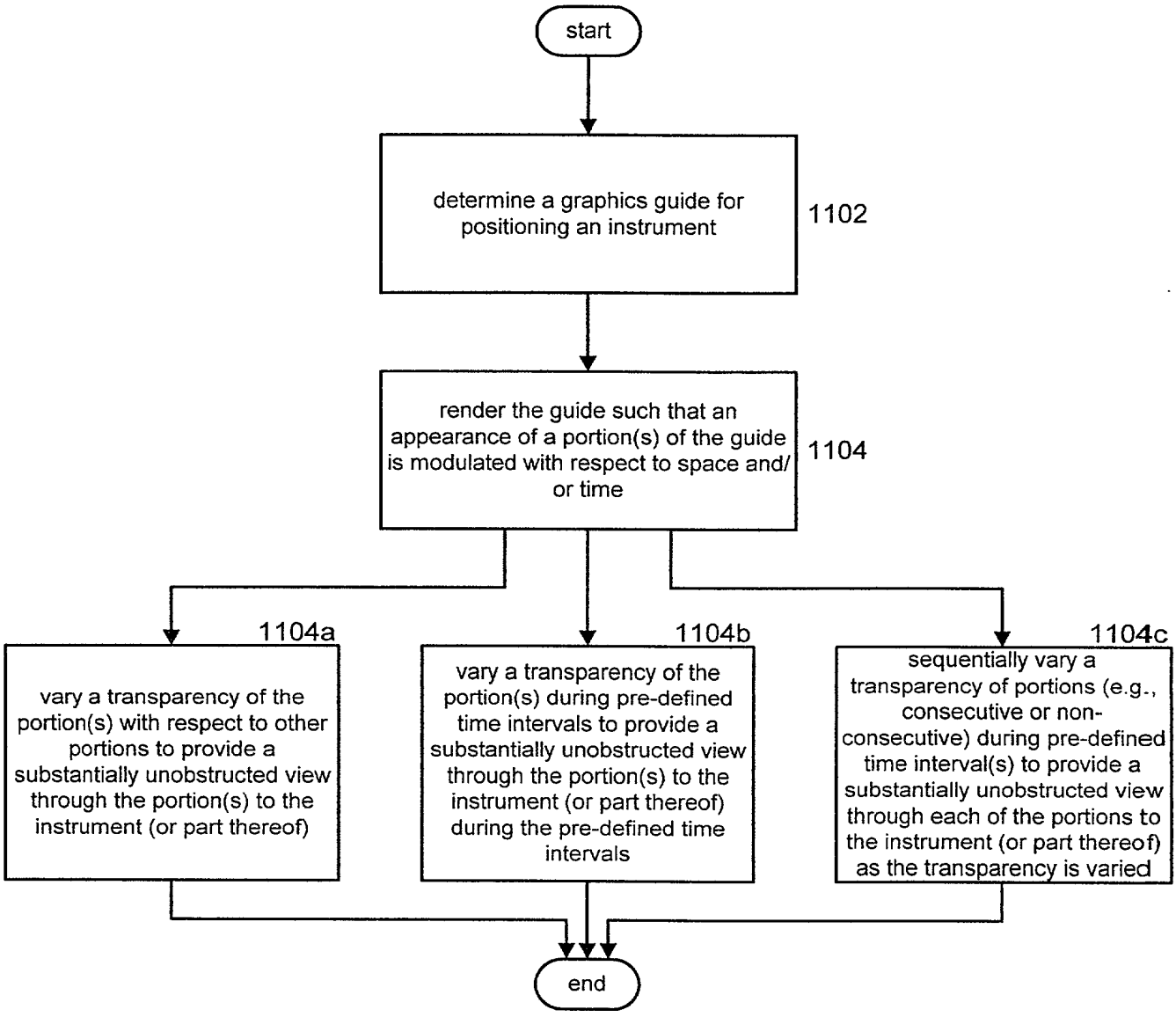

start
determine a graphics guide for positioning an instrument
1102
render the guide such that an appearance of a portion(s) of the guide is modulated with respect to space and/or time
1104
1104a
vary a transparency of the portion(s) with respect to other portions to provide a substantially unobstructed view through the portion(s) to the instrument (or part thereof)
1104b
vary a transparency of the portion(s) during pre-defined time intervals to provide a substantially unobstructed view through the portion(s) to the instrument (or part thereof) during the pre-defined time intervals
1104c
sequentially vary a transparency of portions (e.g., consecutive or non-consecutive) during pre-defined time interval(s) to provide a substantially unobstructed view through each of the portions to the instrument (or part thereof) as the transparency is varied
end

FIG. 11A

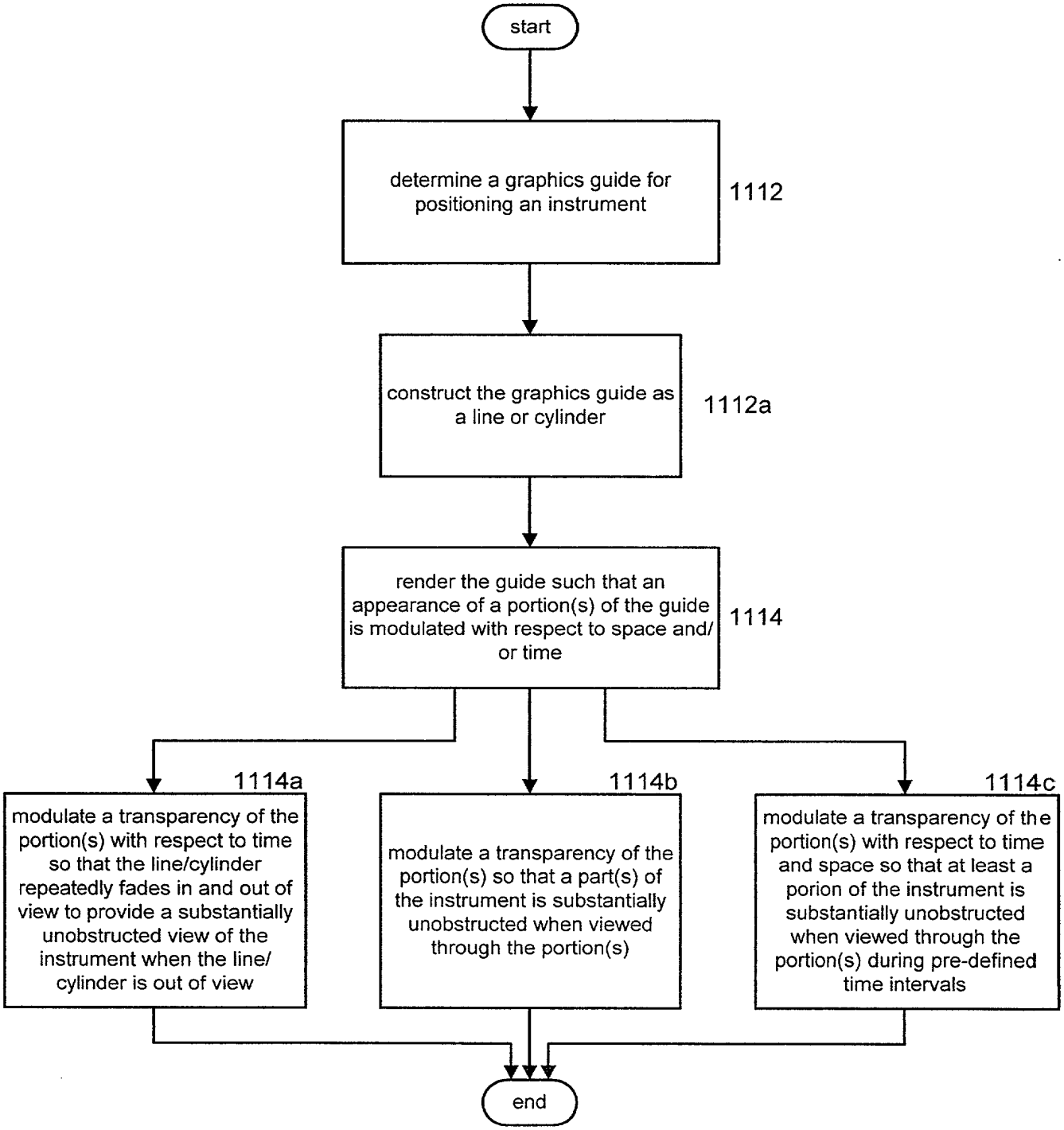

start
determine a graphics guide for positioning an instrument
1112
construct the graphics guide as a line or cylinder
1112a
render the guide such that an appearance of a portion(s) of the guide is modulated with respect to space and/or time
1114
1114a
modulate a transparency of the portion(s) with respect to time so that the line/cylinder repeatedly fades in and out of view to provide a substantially unobstructed view of the instrument when the line/cylinder is out of view
1114b
modulate a transparency of the portion(s) so that a part(s) of the instrument is substantially unobstructed when viewed through the portion(s)
1114c
modulate a transparency of the portion(s) with respect to time and space so that at least a porion of the instrument is substantially unobstructed when viewed through the portion(s) during pre-defined time intervals
end

FIG. 11B

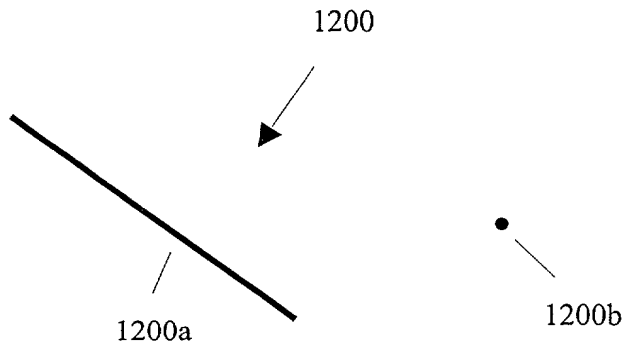


FIG. 12

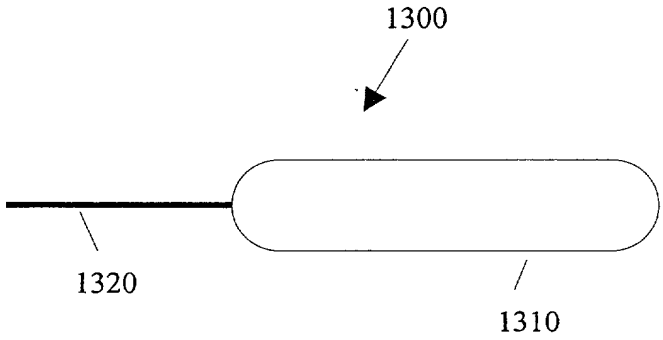


FIG. 13

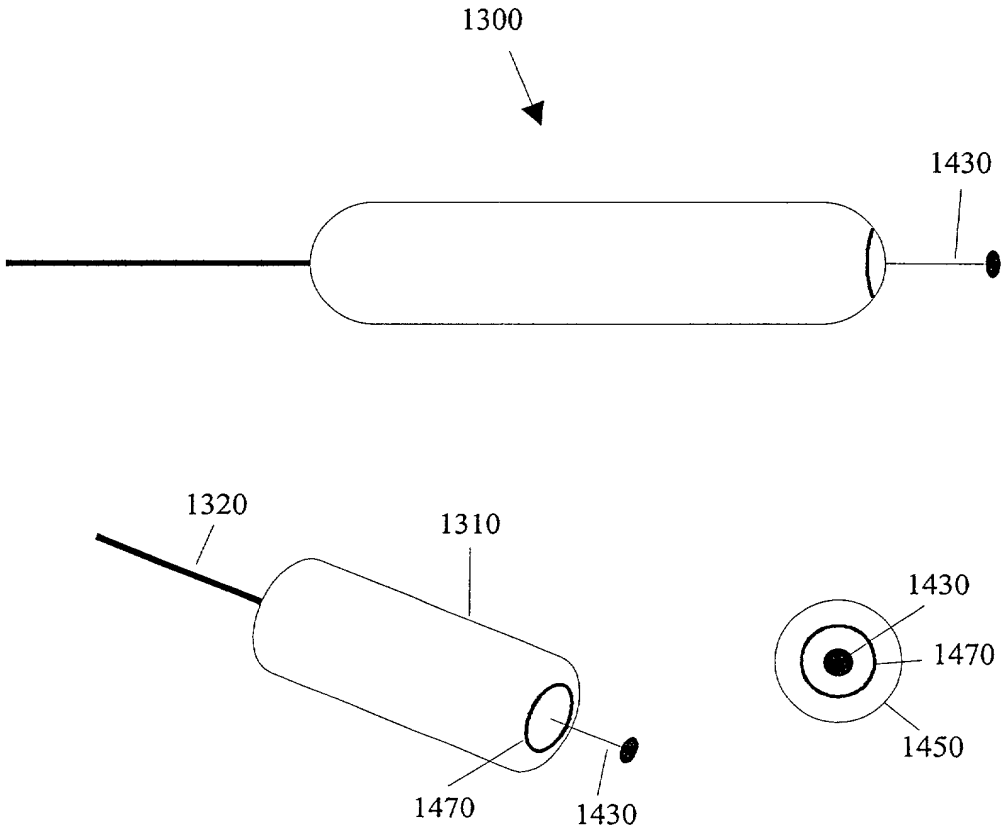
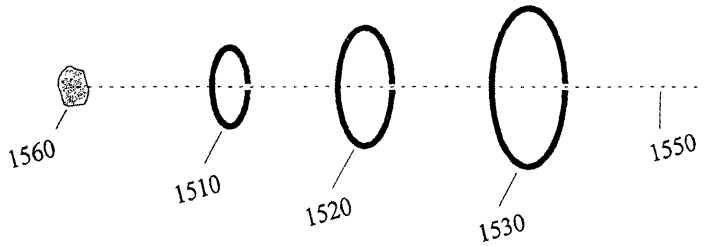


FIG. 14



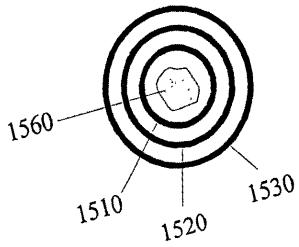


FIG. 15

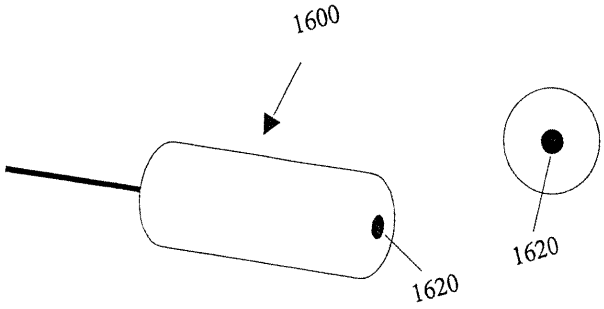


FIG. 16

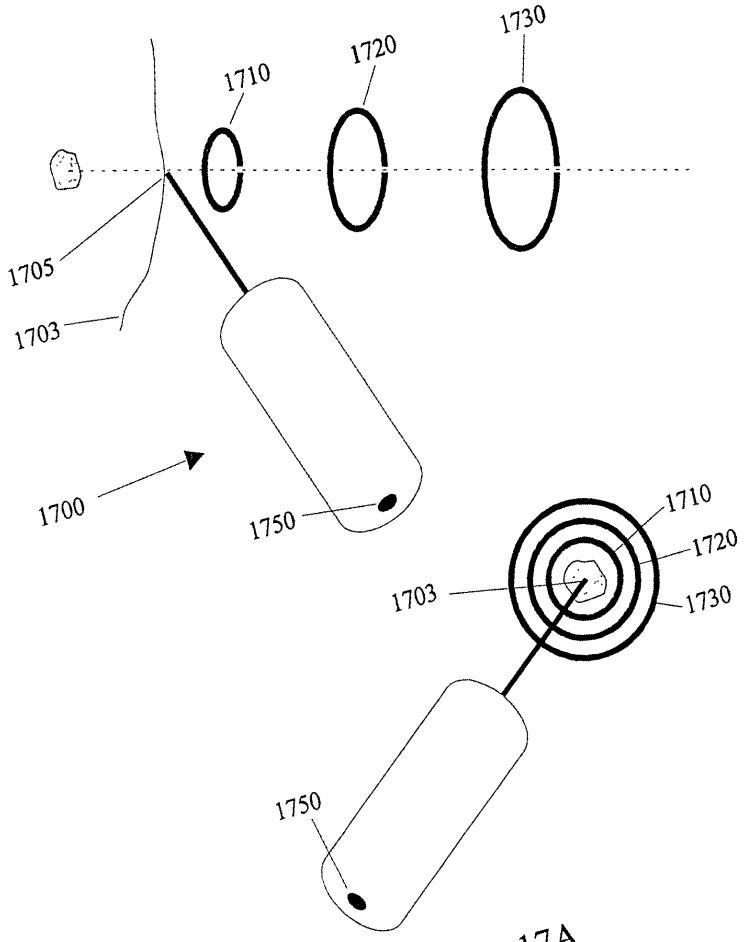


FIG. 17A

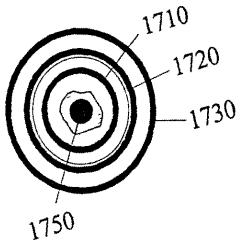


FIG. 17B

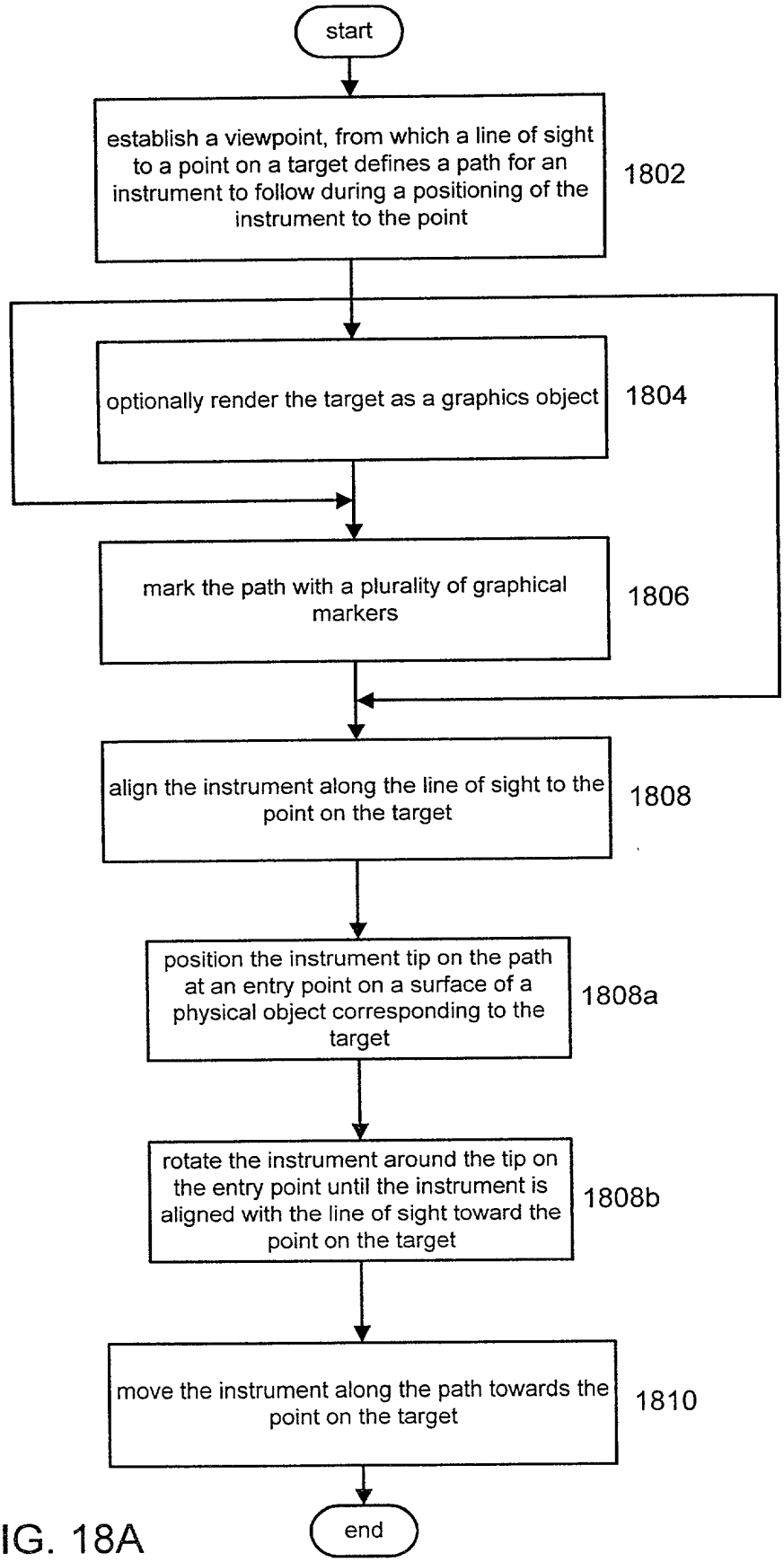

start
establish a viewpoint, from which a line of sight to a point on a target defines a path for an instrument to follow during a positioning of the instrument to the point
1802
optionally render the target as a graphics object
1804
mark the path with a plurality of graphical markers
1806
align the instrument along the line of sight to the point on the target
1808
position the instrument tip on the path at an entry point on a surface of a physical object corresponding to the target
1808a
rotate the instrument around the tip on the entry point until the instrument is aligned with the line of sight toward the point on the target
1808b
move the instrument along the path towards the point on the target
1810
end

FIG. 18A

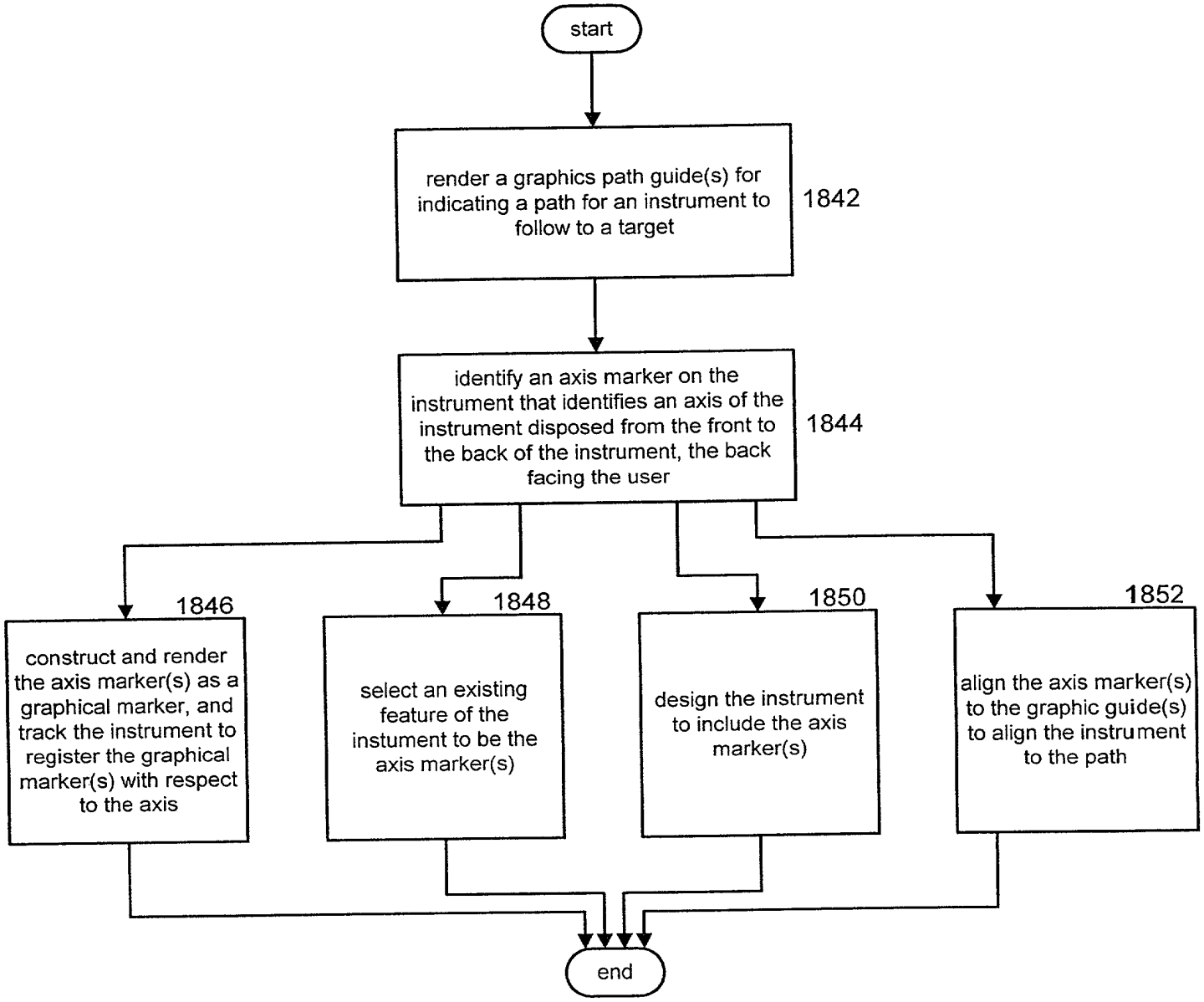
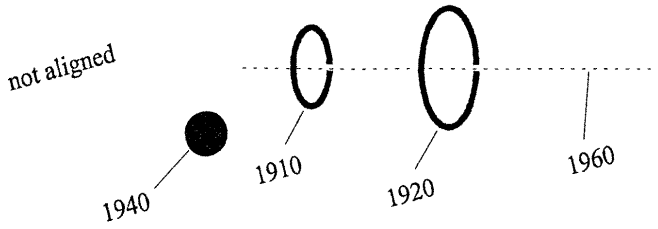

start
render a graphics path guide(s) for indicating a path for an instrument to follow to a target
1842
identify an axis marker on the instrument that identifies an axis of the instrument disposed from the front to the back of the instrument, the back facing the user
1844
1846
construct and render the axis marker(s) as a graphical marker, and track the instrument to register the graphical marker(s) with respect to the axis
1848
select an existing feature of the instument to be the axis marker(s)
1850
design the instrument to include the axis marker(s)
1852
align the axis marker(s) to the graphic guide(s) to align the instrument to the path
end

FIG. 18B



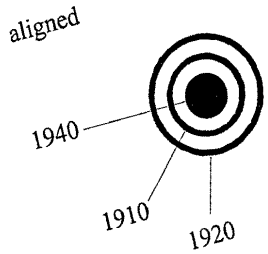
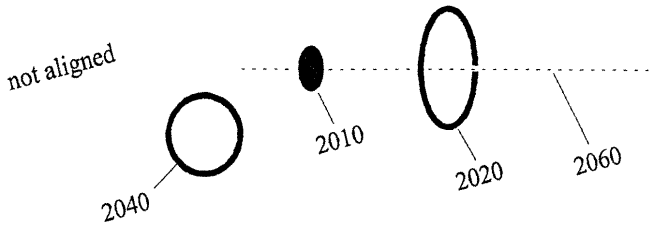


FIG. 19



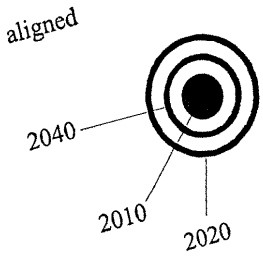
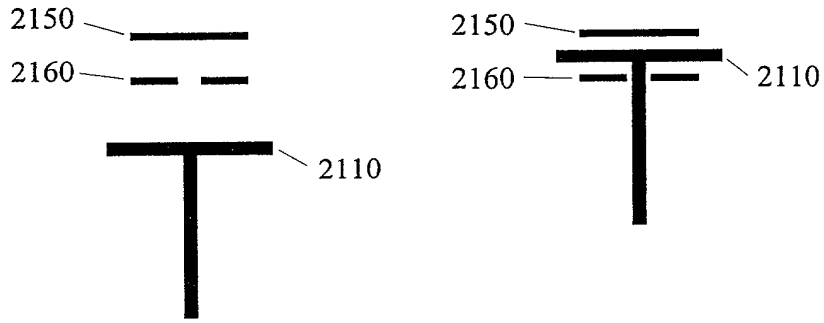


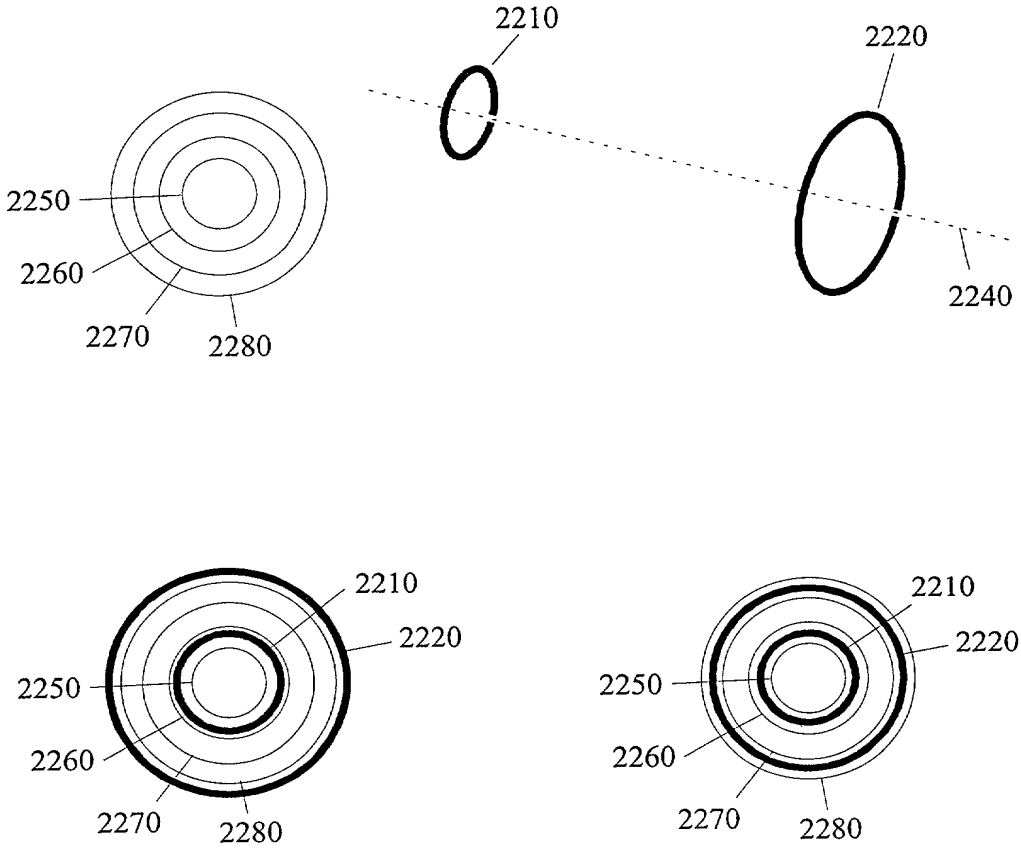
FIG. 20



target depth not yet reached

taget depth reached

FIG. 21



aligned with path,
but not at correct depth

aligned with path,
and at correct depth

FIG. 22

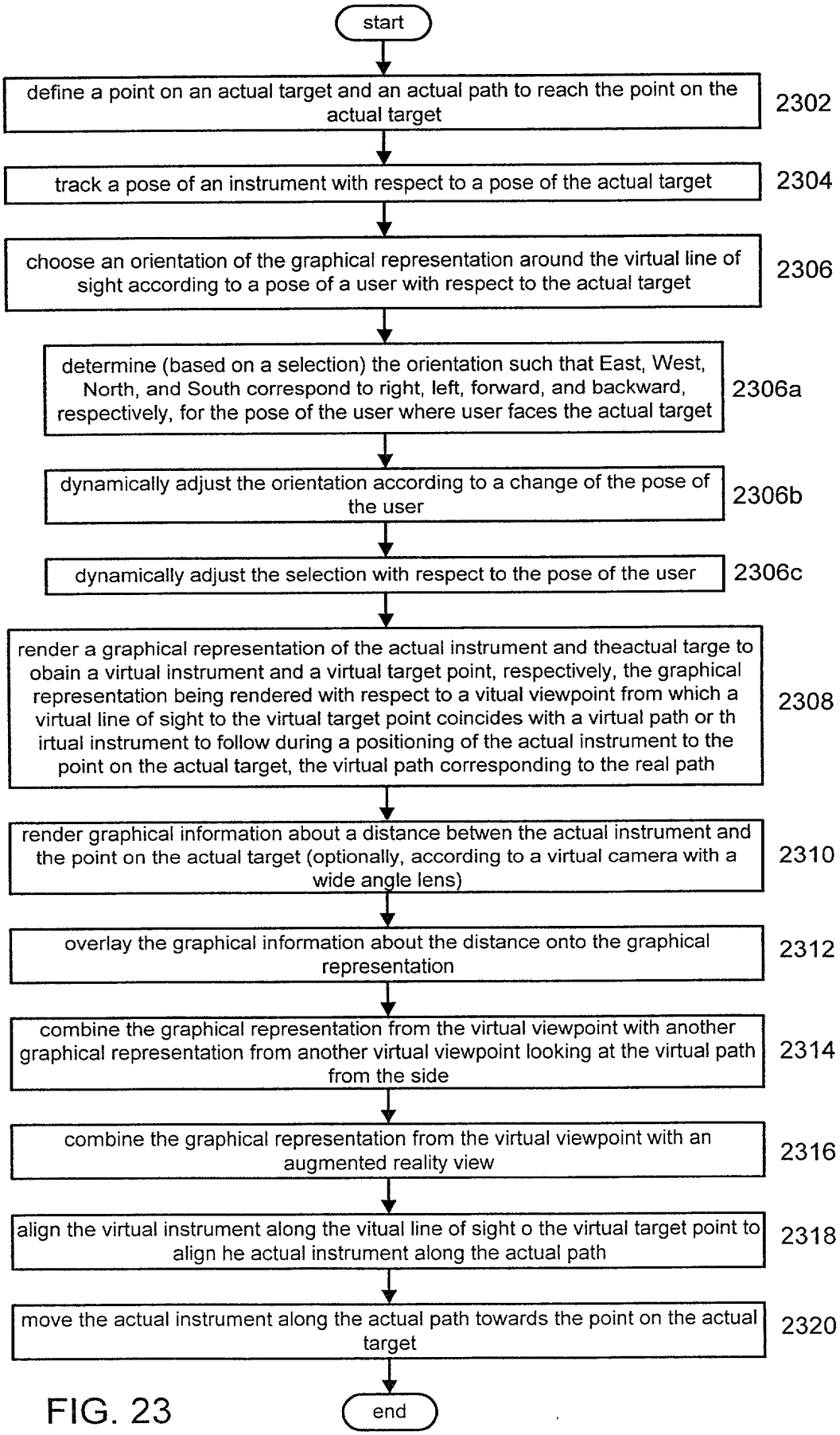

start
define a point on an actual target and an actual path to reach the point on the actual target
2302
track a pose of an instrument with respect to a pose of the actual target
2304
choose an orientation of the graphical representation around the virtual line of sight according to a pose of a user with respect to the actual target
2306
determine (based on a selection) the orientation such that East, West, North, and South correspond to right, left, forward, and backward, respectively, for the pose of the user where user faces the actual target
2306a
dynamically adjust the orientation according to a change of the pose of the user
2306b
dynamically adjust the selection with respect to the pose of the user
2306c
render a graphical representation of the actual instrument and theactual targe to obain a virtual instrument and a virtual target point, respectively, the graphical representation being rendered with respect to a vitual viewpoint from which a virtual line of sight to the virtual target point coincides with a virtual path or th irtual instrument to follow during a positioning of the actual instrument to the point on the actual target, the virtual path corresponding to the real path
2308
render graphical information about a distance betwen the actual instrument and the point on the actual target (optionally, according to a virtual camera with a wide angle lens)
2310
overlay the graphical information about the distance onto the graphical representation
2312
combine the graphical representation from the virtual viewpoint with another graphical representation from another virtual viewpoint looking at the virtual path from the side
2314
combine the graphical representation from the virtual viewpoint with an augmented reality view
2316
align the virtual instrument along the vitual line of sight o the virtual target point to align he actual instrument along the actual path
2318
move the actual instrument along the actual path towards the point on the actual target
2320
end

FIG. 23

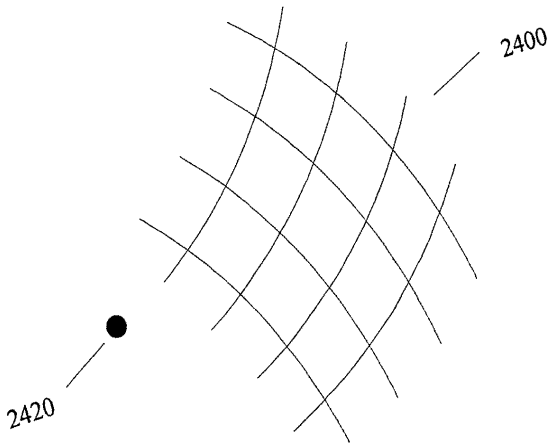


FIG. 24

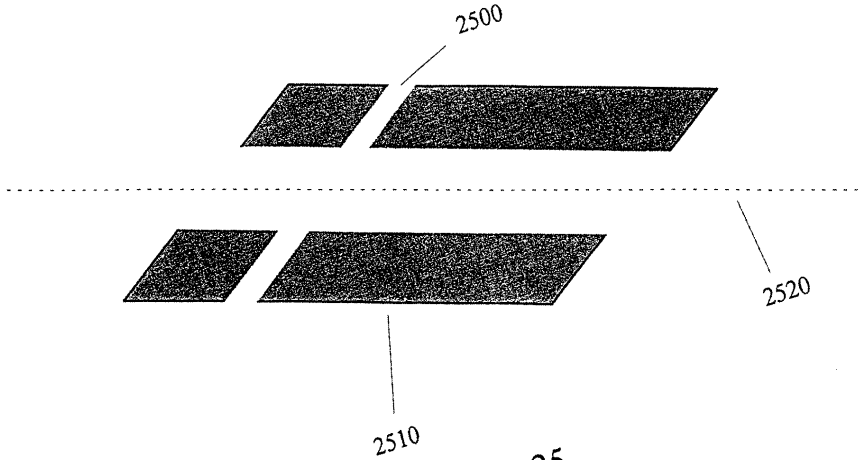


FIG. 25

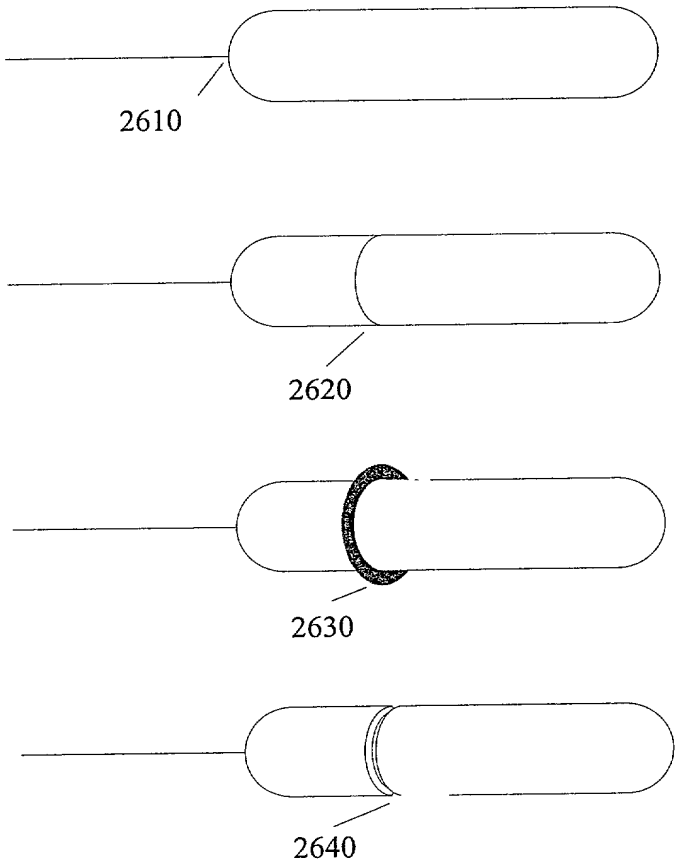


FIG. 26

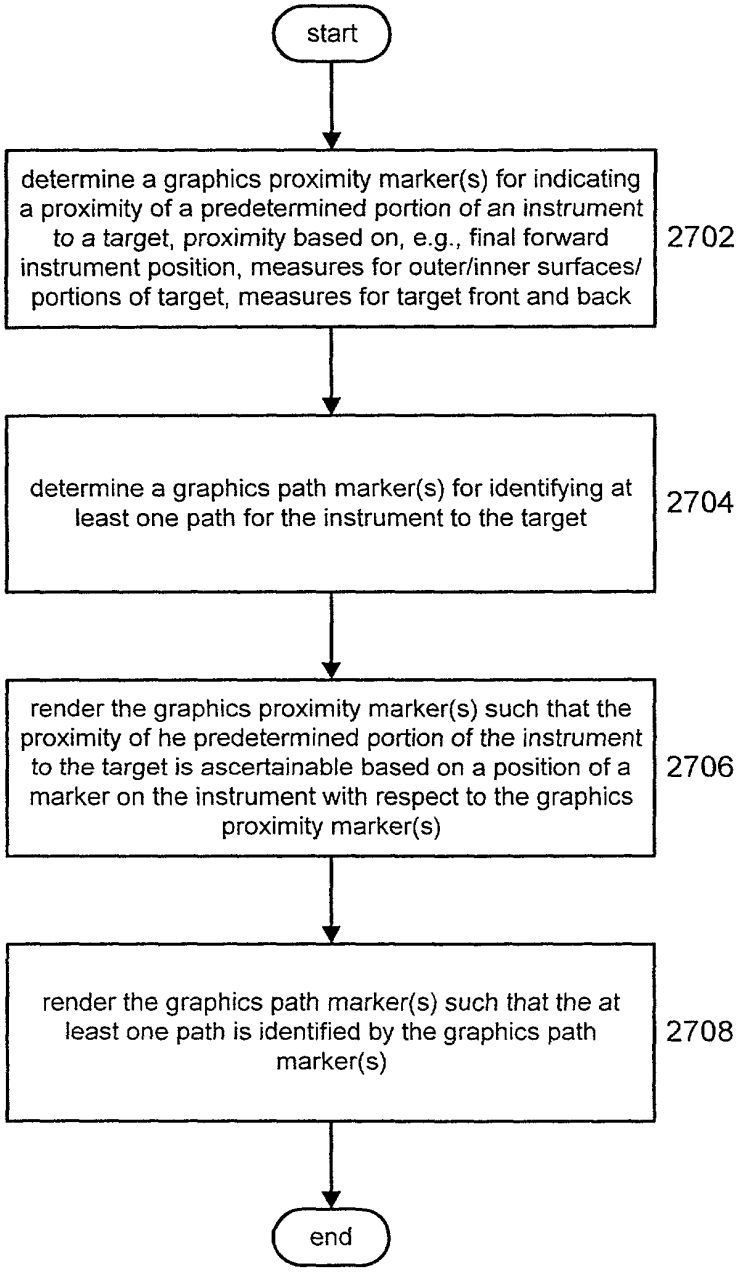

start
determine a graphics proximity marker(s) for indicating a proximity of a predetermined portion of an instrument to a target, proximity based on, e.g., final forward instrument position, measures for outer/inner surfaces/ portions of target, measures for target front and back
2702
determine a graphics path marker(s) for identifying at least one path for the instrument to the target
2704
render the graphics proximity marker(s) such that the proximity of he predetermined portion of the instrument to the target is ascertainable based on a position of a marker on the instrument with respect to the graphics proximity marker(s)
2706
render the graphics path marker(s) such that the at least one path is identified by the graphics path marker(s)
2708
end

FIG. 27